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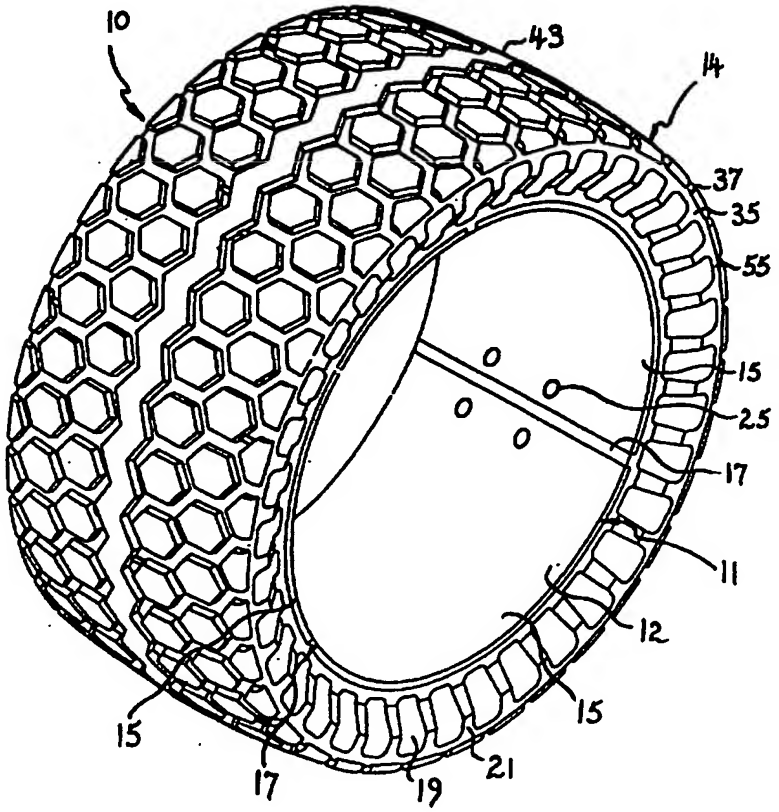
(54) Title: TYRE

(57) Abstract

A tyre (10) comprising an inner band (11) providing the tyre inner circumference. The inner band (11) comprises a plurality of rigid band segments (15) in spaced apart relationship. A resiliently flexible covering (14) is provided on the inner band for engagement with the ground to provide cushioning. The covering (14) provides a flexible link between the band segments (15) thereby allowing the inner circumference of the tyre to be expanded and contracted to allow fitting of the tyre (10) onto a tyre rim. The band segments (15) have mounting holes (25) for receiving mounting bolts for affixing the band segments to the wheel rim. The covering (14) may include a plurality of core holes (19) each extending inwardly from at least one side (21) of the tyre. Each core hole (19) may be dimensioned to be larger at an inner region thereof than at the outer region which opens onto the side (21). A moulded structure is also described and claimed.



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"TYRE"

TECHNICAL FIELD

The present invention relates to a tyre.

BACKGROUND OF THE INVENTION

The invention has been devised particularly, although not solely, as a non-pneumatic tyre.

Non-pneumatic tyres of a one-piece construction are well-known and are typically used in industrial applications, such as on forklifts, where pneumatic tyres would be susceptible to puncturing.

A known system of fastening a non-pneumatic tyre to a wheel rim involves the incorporation of an inner peripheral steel band into the tyre. Tyres employing such a fastening system are commonly known as pressed-on type tyres. The steel band is precision machined so that its inner diameter is marginally smaller than the outer diameter of the wheel rim whereby the inner band is an interference fit on the wheel rim. The interference fit provides the mechanism for transmission of drive between the wheel rim and the tyre. Because of the interference fit, it is necessary to force the tyre onto the wheel rim in some way, such as by using a press.

The interference fit between the tyre and the wheel rim presents difficulties in circumstances where the tyre has to be changed in the field or at other locations where a press is not readily available.

Furthermore, the need to precision machine both the band and the rim contributes significantly to the cost of the tyres and of wheels equipped with such tyres.

With a view to avoiding the difficulties which exist with pressed-on tyres as described above, there have been proposals to produce non-pneumatic tyres as segments which are individually affixed to a wheel rim. While tyres assembled from tyre segments do have many advantages, they do have a significant disadvantage in that considerable time is usually required to assemble the tyre segments onto a wheel rim.

There is a need for a one-piece tyre which can be readily fitted onto a wheel rim. The present invention seeks to provide such a tyre.

SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided a tyre having an inner circumference, the tyre comprising an inner band providing portion of the inner circumference and a resiliently flexible covering provided on the inner band, the inner circumference being of resiliently variable size.

Preferably the inner band is of a more rigid construction than the covering. Conveniently, the inner band is substantially rigid.

The inner band is of a construction for varying the size of the inner circumference, the arrangement being such that the resiliently flexible covering resiliently resists variation in the size of the inner circumference. In this regard, the construction of the inner band comprises a split formed therein. The split allows the circumference of the inner band to expand and contract.

The inner band may be formed of a rigid material such as metal and the resiliently flexible outer covering may be formed of an elastomeric material such as rubber. The inner band may, of course, be constructed of any other suitable material such as a mesh material.

There may b more than one split in the inner band. In such circumstances, the inner band may comprise a plurality of band segments. Th segment may be positioned in spaced apart relationship, the spacing between the band segments providing the splits in the inner band.

The tyre according to the invention is adapted to be fitted onto a central support such as a wheel rim having an outer circumference. The construction of the tyre allows the inner circumference of the tyre to be varied so that it can be brought into engagement with the outer circumference of the wheel rim. Typically, the inner circumference of the tyre would be marginally smaller than the circumference of the wheel rim whereby the tyre can be fitted onto the wheel rim by radial expansion of the inner circumference. However, it is also possible for the inner circumference of the tyre to be marginally larger than the outer circumference of the wheel rim whereby the tyre can be fitted onto the wheel rim by radial contraction of the inner circumference of the tyre. Means such as bolts would be required to maintain the band in the radially contracted condition on the rim.

The wheel rim may comprise a conventional rim of the type adapted to receive conventional pressed-on type tyres.

While it may be possible to retain the tyre on the wheel rim by way of interference between the inner band and the rim, it is preferable for there to be a retaining means for such purpose or at least to supplement retention provided by any interference fit. While the retaining means may take any suitable form, a particularly convenient arrangement comprises apertures provided in the inner band for registering with corresponding apertures in the wheel rim whereby fixing elements such as bolts may be positioned within the registering apertures to affix the tyre to the wheel rim. In another arrangement, the retaining means may comprise engaging m ans on the rim and/or on the inner band for effecting engagement between the inner band and the rim. One form of such ngaging

means may comprise tabs on the inner band which can be bent into a position in which they engag the rim.

A guide means may be provided for properly aligning the tyre with respect to the wheel rim during fitting of the tyre. This is for the purpose of ensuring that the inner band is correctly positioned with respect to the rim such that any mounting apertures or tabs on the inner band register with corresponding apertures in the rim.

The guide means may comprise a protrusion on the rim adapted to be received in a gap in the inner circumference of the tyre. The gap may be provided by the split, or one of the splits, in the inner band of the tyre. With this arrangement, the tyre is first positioned with respect to the rim such that one of the splits in the inner band is aligned with the protrusion, and the tyre is then urged onto the rim such that the protrusion enters the split and guides the tyre onto the rim in the correct position.

The inner band (including each segment of the inner band) may have a radius of curvature which is either the same as, or different to, that of the outer circumference of the wheel rim. Where the radius curvature of the band is different to that of the circumference of the rim, the inner band (including each segment thereof) would be required to undergo deflection in order to sit properly on the rim when retained thereon. The deflection of the inner band may be advantageous as it would induce a pre-load in the tyre which can be beneficial in terms of the service life of the tyre by contributing to a reduction in the extent of fatigue in the inner band.

Where the radius of curvature in the inner band (including each segment thereof) is larger than the radius of curvature of the rim, it may only be necessary for the retaining means to be provided at the ends of the band or at the ends of each segment of the band.

Where the radius of curvature of the inner band (including of ach segment thereof) is smaller than th radius of curvature of the rim, it may only be necessary for the retaining means to be provided at the inner region of the band or the inner region of each segment of the band.

The resiliently flexible outer covering may be moulded or otherwise bonded onto the inner band.

The inner band may have a formation which protrudes onto the resiliently flexible outer covering. The formation may be provided for enhancing the strength of the band, or for reducing the volume of the material providing the resiliently flexible covering, or for both purposes.

The inner band may have means for providing a mechanical bond with the resiliently flexible covering. This may be accomplished by providing the inner band with one or more apertures into which material providing the resiliently flexible outer covering is received to form the mechanical bond. The material providing the resiliently flexible outer covering may also occupy the or each split in the inner band.

Preferably the resiliently flexible outer covering is of non-pneumatic construction.

The resiliently flexible outer covering may comprise a body of resilient material such as rubber. The body may one or more have cavities formed therein to enhance the resilient characteristics of the body of elastomeric material.

The resiliently flexible outer covering may be a moulded structure comprising a moulded body of resiliently deformable material and the or each cavity formed therein may comprise a core hole extending into the moulded body from a face thereof. The core hole may b so shaped as to provide an outer dimensional characteristic at an outer zone at or n ar the face of the moulded body and an intermediate dimensional characteristic of the same character as the outer

dimensional characteristic at an intermediate zone disposed inwardly of the outer zone, the intermediate dimensional characteristic b ing larger than th outer dimensional characteristic.

Such an arrangement provides a core hole which is larger at the inner region thereof than at the outer region. This is contrary to conventional moulding practice where a core hole is either tapered inwardly or is at least straight in its longitudinal direction so as to facilitate withdrawal of a core forming the core hole from the moulded body.

In the moulded structure according to the invention, the intermediate and outer dimensional characteristics may be of any suitable character such as a dimension transverse to the inward extent of the core hole, or a cross-sectional area at a plane transverse to the inward extent of the core hole.

The body may have a second face and the core hole may extend between the first and second faces. With such an arrangement, the core hole may have a second outer zone at or near the second face of the body, the second outer zone having a second outer dimensional characteristic, the intermediate dimensional character being larger than the second outer dimensional characteristic.

In another arrangement, core holes may extend inwardly from the first and second faces. The core holes in the first face may be aligned with, or staggered in relation to, the core holes in the second face. Staggering of the core holes may allow the tyre to provide a more even ride. Further, the core holes in the first and second faces may be so dimensioned and arranged that a central web extending circumferentially within the moulded body may be defined between the core holes.

Preferably, the dimensional characteristics of the or each core hole change progressively between the or each outer zone and the intermediate zone.

Conveniently, the intermediate zone is centrally located within the moulded body.

The or each core hole may have a ceiling portion adjacent an outer portion of the body and a floor portion adjacent an inner portion of the body, the ceiling portion being shaped to provide the change in dimensional characteristics at the or each outer zone and the intermediate zone. This may be accomplished in various ways, such as by tapering the ceiling portion such that it diverges from the floor portion in the inward direction of the core hole from the or each outer region to the intermediate region. The tapering may be planar or arcuate. Where the tapering is arcuate, the ceiling portion of the core hole may assume a domed formation.

The floor portion may be of a configuration which is constant throughout the core hole or may vary between the or each outer zone and the intermediate zone. The variation between the outer zones and the intermediate zone may take any suitable form, one such form being a waisted arrangement wherein the floor portion tapers inwardly, but not to an extent which negates the effect of the tapering of the ceiling portion.

It has been found that the increase in the dimensional characteristic of the core hole in the inner direction does not prevent removal of cores from the moulded body during the production process. There is adequate resiliency within the moulded body to allow for the cores to be removed.

According to another aspect of the invention there is provided a central support having a circumferential support surface for supporting a tyre according to the first aspect of the invention as defined above.

According to still another aspect of the invention there is provided a wheel comprising a tyre according to a first aspect of the invention fitted onto a central support according to another aspect of the invention.

According to still another aspect of the invention there is provided a moulded structure comprising a moulded body of resiliently deformable material and a core hole extending into the body from a face thereof, the core hole being so shaped as to provide an outer dimensional characteristic at an outer zone at or near the face of the body and an intermediate dimensional characteristic of the same character as the outer dimensional characteristic at an intermediate zone disposed inwardly of the outer zone, the intermediate dimensional characteristic being larger than the outer dimensional characteristic.

The moulded structure may comprise a one-piece tyre or a tyre segment which along with similar such segments can be assembled onto a wheel rim to provide a composite tyre.

Where the moulded structure is a tyre, it need not necessarily be a tyre of the type defined hereinbefore having an inner band of resiliently variable size and in particular it need not be such a tyre in which the inner band is of a rigid construction incorporating one or more splits to accommodate variations in size. Indeed, the tyre may be of any type which incorporates a core hole.

According to still another aspect of the invention there is provided a tyre comprising a resiliently deformable annular body including an inner portion having an inner face for positioning on a support surface, an outer portion having an outer face disposed outwardly of the inner portion for engaging the ground, and opposed side faces extending between the inner and outer faces, and wherein a plurality of core holes are formed in the annular body to extend between the opposed side faces, the core holes each having a cross-sectional configuration which is not constant b tw en the ends thereof and which provides

a dimensional characteristic intermediate the ends thereof which is greater than a corresponding dimensional characteristic at or near the ends thereof.

The dimensional characteristic may comprise the cross-sectional area of the core hole. With such an arrangement, the cross-sectional area of the core hole may progressively increase in the inward extent from each end of the hole towards the centre of the length of the core hole.

Conveniently, the increase in the cross-sectional area of the core hole arises at least in part by tapering of the core hole towards the outer face of the tyre in the inward direction of the core hole.

Preferably, the outer face of the tyre has a profile in which the central region is raised with respect to the side regions (commonly referred to as a crown profile), and the tapering of the ceiling portion of the core hole corresponds generally to the profile of the outer surface such that there is a generally uniform thickness between the ceiling portion of the core hole and the outer face of the tyre.
This arrangement is useful as it can assist in providing the tyre with a more even and consistent ride characteristic, and may contribute to lowering rolling resistance of the tyre.

The tyre according to this aspect of the invention may be a one-piece tyre or a composite tyre assembled from a plurality of tyre segments.

According to still another aspect of the invention there is provided a tyre segment comprising a resiliently deformable body including an inner portion having an inner face for positioning on a support surface, an outer portion having an outer face disposed outwardly of the inner portion for engaging the ground, and opposed side faces extending between the inner and outer faces, and wherein a core hole is formed in the annular body to extend between the opposed side faces, the core hole having a cross-sectional configuration which is not constant between the ends thereof and which provides a dimensional

characteristic intermediate the ends thereof which is gr ater than a corr sponding dimensional characteristic at or near the ends thereof.

There may be a plurality of such core holes in the body.

According to still another aspect of the invention there is provided a mould for producing a moulded structure as defined as hereinbefore, the mould having a core for producing a respective core hole in the moulded structure, the core being configured to provide the variation in dimensional characteristics of the core hole as previously described.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood by reference to the following description of various specific embodiments thereof as shown in the accompanying drawings in which:

Figure 1 is an isometric view of a tyre according to a first embodiment;

Figure 2 is a fragmentary side view of the tyre according to the first embodiment shown fitted onto a wheel rim;

Figure 3 is a cross-section view of the tyre fitted onto a wheel rim;

Figure 4 is an isometric view of a core for producing a core hole in the tyre of the first embodiment;

Figure 5 is a side view of the core of Fig. 4;

Figure 6 is an end view of the core of Fig. 4;

Figure 7 is a perspective view of an alternative form of core for forming the core hole of the tyre according to the first embodiment,

Figure 8 is a side view of the core shown in Fig. 7;

Figur 9 is a cross-sectional view of a tyre according to a second mbodim nt;

Figure 10 is an elevational view of a tyre according to a third embodiment, with a portion cut- away to reveal core holes within the tyre;

Figure 12 is a fragmentary view illustrating a segment of an inner band which forms part of a tyre according to a fifth embodiment in association with a wheel rim;

Figure 13 is a view similar to Figure 12 in relation to a tyre according to a sixth embodiment;

Figure 14 is a schematic perspective view of a tyre according to a seventh embodiment;

Figure 15 is a side view of the tyre of figure 14;

Figure 16 is a cross-section along the line 16-16 of Figure 15;

Figure 17 is a perspective view of a tyre of a seventh embodiment fitted onto a wheel rim to provide a wheel;

Figure 18 is side view of the wheel shown in figure 17;

Figure 19 is a cross-section on the line 19-19 of figure 18;

Figure 20 is a schematic perspective view of the wheel rim for the wheel shown in Figure 17;

Figure 21 is side view of the wheel rim of figure 20; and

Figure 22 is a cross-section along the lines 22-22 of figure 21.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to figs 1 to 6 of the drawings, the first embodiment is directed to a non-pneumatic tyre 10 comprising an inner band 11 having an inner face 12 and an

outer face 13, and an outer covering 14 provided on the inner band. The inner band 11 is of substantially rigid construction, being formed of any suitable material such as steel. The band 11 comprises a plurality of band segments 15 in spaced apart relationship to define gaps 17 therebetween. This construction provides the band 11 with a plurality of splits defined by the gaps 17.

The outer covering 14 comprises an annular body formed of an elastomeric material which is bonded onto the inner band 11. The elastomeric material may be of any suitable form such as rubber. The covering 14 is resiliently flexible to provide the tyre with a cushioning characteristic. In this embodiment, the resilient nature of the outer covering 14 is enhanced by the provision of cavities 19 which extend through the tyre between opposed sides 21 thereof. The cavities 19 enhance resilient deformation of the body, reduce the volume of elastomeric material required to form the body, and provide ventilation within the body for the purposes of cooling the tyre.

The resiliently flexible outer covering 14 provides a flexible link between the band segments 15 thereby allowing the inner band 11 to be resiliently expanded and contracted to allow fitting of the tyre onto a tyre rim 23 as will be explained later. The band is provided with a plurality of mounting holes 25 for releasably retaining the tyre onto the rim 23, as will also be explained later. The mounting holes are positioned so as to open onto the cavities 19. This provides access to the mounting holes from the outer side of the band 11.

The rim 23 has an outer circumferential face 27 against which the inner face 12 of the band 11 bears when the tyre is fitted onto the rim.

The band 11 is dimensioned such that the inner circumference of the tyre is marginally smaller than the outer circumference of the rim 23. With this arrangement, it is necessary to marginally expand the band 11 by increasing the size of the gaps 17 to allow it to be fitted onto the rim 23. This expansion of the band 11 can be accomplished by forcing the band 11 onto the rim 23, possibly

with the aid of a tool such as a rubber mallet. The resili nt nature of the outer covering 14 allows the band 11 to xpand for fitment on the rim 23. The band 11 is positioned on the rim 23 such that the mounting holes 25 register with corresponding mounting holes 28 in the rim whereby fixing elements 29 such as bolts can be fitted to secure the band to the rim. The use of bolts 29 to secure the band to the rim is particularly convenient and allows the tyre to be readily removed from the rim if necessary.

A guide means 31 is provided for properly aligning the inner band 11 of the tyre 10 with respect to the rim 23 to ensure that the mounting holes 25 in the band 11 register with the mounting holes 28 in the rim. The guide means 31 comprises a protrusion on the outer face 27 of the rim. The protrusion 31 is so positioned that the tyre 10 is properly aligned with the rim when on of the gaps 17 in the band 11 is aligned with the protrusion. During fitting of the tyre, the protrusion 33 enters the particular gap 17 with which it is aligned and guides the tyre 10 into the correct position on the rim 23 such that the moulding holes 25 register with the moulding holes 28.

A convenient way of producing the tyre would be to incorporate the tyre segments 15 into a mould in which the outer covering 14 is formed, and thereby mould the outer covering 14 directly onto the band segments 15. In this way, the splits 17 in the band 11 are formed prior to moulding of the outer covering 14 onto the band. It may, however, also be possible to mould the outer covering 14 onto a band 11 which has not been split and then form the splits in the band after the moulding process.

When the splits 17 are present in the inner band 11 during the moulding operation, the gap provided by the split would be occupied by the elastomeric material forming the outer covering 14.

The annular body which provides the outer covering 14 c mprises an outer portion 35 having an outer face 37 for engagement with the ground, and an inn r

portion 39 having an inner face 40 bonded to the inner band 11. The annular body 14 also has a pair of opposed side faces 41 which extend between the outer face 37 and the inner face 40 and which provide the sides 21 of the covering..

The outer portion 35 incorporates a tread formation 43 forming part of the outer face 37.

The tread formation 43 is of a crowned profile such that the inner region 45 thereof extends radially outwardly further than the side regions 47, as is conventional practice with tyres. The crowning of the tread formation 43 enhances ride comfort and provides improved steering.

The cavities 19 are provided by core holes which extend between and open onto the side faces 41 of the annular body.

Each core hole 19 comprises a ceiling portion 49 adjacent the outer portion 35, a floor portion 51 adjacent the inner portion 21 and side portions 53 extending between the inner and outer portions.

Each core hole 19 is of a cross-section which is not constant throughout the length of the core hole between the ends thereof. More particularly, each core hole 19 within the outer covering 14 has a cross-sectional area transverse to the inward extent of the core hole 19 which progressively increases from each end thereof towards the centre of the length of the core hole.

The increasing cross-sectional area is provided by tapering the ceiling portion 49 such that the spacing between the ceiling portion and the floor portion 51 progressively increases from each end of the core hole 19 to the centre of the length thereof, as best seen in Fig 3 of the drawings. This tapering may be planar or arcuate so as to provide a somewhat domed formation within the core hole.

A benefit of this arrangem nt is that a substantially uniform thickness can be attained in the region 55 of the outer portion 35 between the outer face 37 and the core hole 19. This uniform thickness is beneficial as it can enhance the evenness and consistency of the ride characteristic of the tyre and can also contribute to lowering of the rolling resistance of the tyre.

Figs. 4, 5 and 6 show a core 60 which can be used for producing core holes 19 in the tyre according to this embodiment.

The annular body which provides the outer covering 14 is moulded using conventional techniques with the cores 60 being located in the moulds to produce the core holes 19. After the moulding operation has been completed, the cores 60 are removed from the mould. It is conventional wisdom that with such moulding procedures it is necessary for the cores 60 to have a profile such that the side walls thereof either taper inwardly towards each other or are substantially straight to facilitate removal of the core from the moulded article. The core holes 19 and the cores 60 are not constructed in accordance with such conventional wisdom but nevertheless it has been found that the cores can be conveniently and readily easily removed in unison from the moulded body because of the resilient nature of the material from which it is made.

There are situations where it may be advantageous or convenient to utilise cores which are of two-part construction which can be removed from opposed sides of the tyre. An example of such a two-part core 61 is illustrated in Figs. 7 and 8 of the accompanying drawings. The use of two-part cores allows the tyre to be moulded with core holes which do not extend completely through the body of the tyre. This can be of benefit as it allows the tyre to be formed with a continuous central web extending circumferentially within the tyre.

Referring now to Fig. 9 of th drawings, there is shown a second embodiment of a tyre according to the invention which is somewhat similar to the first

embodiment with the exception that the floor portion 51 of each core hol 19 is also shaped to xtend away from the ceiling portion in the inward direction of the tyre so as to enhance the increase in cross-sectional area of the tyre in the inward direction from each end to the middle of the core.

In the third embodiment, which is shown in Fig 10, the progressive increase in cross-sectional area in the inward direction of each core hole 19 is provided by tapering of the side portions 53 of the core hole such that the spacing between the side wall portions varies in the circumferential direction of the tyre. With the tapering of the side portions 53 of the core holes 19, there is a reduction in the amount of elastomeric material occupying the central region of the tyre where such material is least required.

Fig. 9 illustrated an arrangement where the floor portion 51 is tapered so as to enhance the increase in cross- sectional area of the core hole 19 in the direction from the ends thereof to the middle. Fig 10 illustrated an arrangement where the side portions 53 are tapered for a similar purpose. There may be situations where the floor portion 51 and the adjacent region of the side portions 53 are shaped in some other fashion, such as the waisted formation illustrated in Fig. 11 of the drawings which depicts a core hole 19 as a negative so as to resemble a solid. In this embodiment, the floor portion 51 and the adjacent region of the side portions 53 taper inwardly towards the middle of the core so as to provide a waist 65. As a result of the waist 65, the spacing between the regions of the side portions 53 adjacent the floor portion 51 decreases towards the centre of the core but the resultant reduction in cross-sectional area does not negate the increase in cross-sectional area developed by the tapering of the ceiling portion 49. This arrangement is useful in that it allows the ceiling portion 49 to be profiled so as to provide a substantially uniform thickness in the region 55 of the outer portion 35 between the outer face 37 thereof and the core 31 without significantly varying the cross-sectional area of the core hole.

The band segments 15 in the first mbodiment showing in Figs 1 to 6 are of a radius of curvature which corresponds to th radius curvature of the outer circumference face 27 of the rim 23. In another embodiment, the radius of curvature of the band 11 is slightly smaller than the radius of curvature of the circumference of the rim 23, as can be seen in Figure 12 of the drawings. With this arrangement, a gap 31 exists between the rim 23 and the inner portion of each band segment 15 when the tyre is initially fitted onto the rim. The band segments 15 subsequently deflect to conform to the curvature of the rim as they are pulled into engagement with the rim 23 by the bolts 29. The mounting holes 25 in each band segment 15 can be positioned towards the inner region of the segment; there is less need for mounting holes at the ends of each segment owing to the nature of the curvature. With this arrangement, the band segments 15, and to a lesser extent the resilient covering 14, have an induced pre-load which may serve to extend the service life of the tyre by reducing the occurrence of fatigue.

Figure 13 illustrates a possible variation to the arrangement shown in Figure 12 where the band segments 15 are of a radius of curvature larger than that of the circumference of the rim 23. This arrangement also induces a pre-load in the band segments 15, and to a lesser extent the outer covering 14. With this arrangement, the mounting apertures 25 in the band segments 15 are required towards the ends thereof rather than at the inner region owing to the nature of the curvature.

The embodiments which have been described relate to a non- pneumatic tyres in which the outer covering 14 is formed of elastomeric material having cavities 19 formed therein to enhance the resilient nature of the tyre. It should be appreciated that other arrangements of coverings are possible, including a solid covering and a covering having cavities incorporating inserts of suitable material such as foam. A tyre where the outer covering is of solid construction is illustrated in Figs 14 to 21. Th tyre 71 according to this embodiment is particularly, although not solely, suitable for use on ride-on lawn mowers which

currently use pr ssed-on solid tyres. The tyre 71 is adapted to be fitted onto a wheel rim 73 to provide a wheel 75.

The wheel rim 73 is of the type used with conventional pressed-on solid tyres with the exception that it is provided with mounting holes 76 in its supporting portion 77 and two protrusions 78 on the outer circumferential face 79 of the supporting portion 77. The two protrusions 78 provide a means for properly aligning the tyre 71 with respect to the wheel rim 73 in a similar fashion to the guide means 31 in relation to the tyre 10 of the first embodiment.

The tyre 71 of this embodiment comprises an inner band 81 having an inner face 82 and an outer face 83, and outer covering 84 provided on the inner band. As with the earlier embodiments, the inner band 81 is of substantially rigid constructions and comprises a plurality of bands segments 85 in spaced apart relationship to define gaps 87 therebetween.

The outer covering 84 comprises an annular body formed of resiliently flexible elastomeric material such as rubber which is bonded onto the outer face 83 of the inner band 81. The outer covering 84 is solid in the sense that it not provided with core holes or other cavities to enhance its resilience.

The band 81 is dimensioned such that the inner circumference of the tyre 71 is marginally smaller than the outer circumference of the rim 73. As with the previous embodiments, it is necessary to marginally expand the band 81 by increasing the size of the gaps 87 to allow it to be fitting onto the rim 73.

The band 81 is provided with internally threaded mounting holes 88. The mounting holes 88 are adapted to register with the mounting holes 76 in the wheel rim 73 whereby fixing elements 91 such as bolts can be fitted to secure the inner band 81 to the wheel rim. The fixing elements 91 each have a head 93 and a threaded shank 95. The threaded shank 95 of each fixing lement 91 threadably engages the mounting holes 87 with the head 91 bearing against the

inner side of th supporting portion 77 wheel rim thereby securing the tyre to the wheel rim, as best seen in figure 18 of th drawings.

While the various embodiments which have been described relate to tyres in which the inner circumference of the tyre is marginally smaller than the circumference of the wheel rim such that the tyre can be fitted onto the wheel rim by radial expansion of the inner circumference, it should be appreciated that it is also possible for the inner circumference of the tyre to be marginally larger than the outer circumference of the wheel rim such that the tyre can be fitted onto the wheel rim by radially contraction of the tyre in the circumference. With such an arrangement, fastening means such as bolts could be employed to maintain the inner circumference of the tyre in the radially contracted condition on the rim.

While the various embodiments which have been described relate to tyres in which the outer coverings are non-pneumatic, it should be appreciated that is may be possible for the coverings to be pneumatic in nature.

From the foregoing, it is evident that the present invention provides a tyre which can be simply and conveniently fitted onto a wheel rim.

It should be appreciated that the scope of the invention is not limited to the scope of the various embodiments described.

CLAIMS

1. A tyre having an inner circumference, the tyre comprising an inner band providing portion of the inner circumference and a resiliently flexible covering provided on the inner band, the inner circumference being of resiliently variable size.

2. A tyre according to claim 1 wherein the inner band is of a more rigid construction than the covering

3. A tyre according to claim 1 or 2 wherein the inner band is substantially rigid.

4. A tyre according to claim 1, 2 and 3 wherein the inner band is of a construction for varying the size of the inner circumference and the resiliently flexibly covering resiliently resists variation in the inner circumference.

5. A tyre according to claim 4 wherein the construction of the inner band comprises a split formed therein.

6. A tyre according to claim 4 wherein the construction of the inner band comprises a plurality of band segments positioned in spaced apart relationship, the spacing between the band segments providing a plurality of splits in the inner band.

7. A tyre according to any one of the preceding claims adapted to be fitted onto a central support having a circumferential support surface for receiving and supporting the inner band of the tyre, wherein the inner circumference of the tyre is smaller than the circumference of the support surface whereby the tyre can be fitted onto the central support by radial expansion of the support surface.

8. A tyre according to any one of the pr ceding claims adapted to be fitted onto a c ntral support having a circumferential support surface for receiving and

supporting the inn r band of th tyre, wherein the inner circumference of the tyre is larger than the circumference of th support surface whereby th tyre can be fitted onto the central support by radial contraction of the support surface.

9. A tyre according to claim 7 or 8 further comprising retaining means for releasably retaining the tyre on the support.

10. A tyre according to claim 9 wherein the retaining means comprises at least one aperture provided in the inner band for registering with a corresponding aperture in a support surface whereby a fixing element is receivable within the registering apertures for affixing the tyre to the support.

11. A tyre according to any one of claims 1 to 10 wherein the inner band has an inner circumference equal to the circumference of the support surface of the central support.

12. A tyre according to any one of claims 1 to 10 wherein the inner band has an inner circumference different to the circumference of the support surface of the central support whereby the inner band is required to be deflected for conformity with the curvature of the support surface.

13. A tyre according to claim 12 wherein the radius of curvature in the inner band is larger than the radius of curvature of the rim and the retaining means are provided at the inner region of the band or the inner region of each segment of the band.

14. A tyre according to claim 12 wherein the radius of curvature of the inner band is smaller than the radius of curvature of the rim and the retaining means is provided at the ends of the band or at the ends of each segment of the band.

15. A tyre according to any one of the preceding claims wh rein the resili ntly flexible outer covering is moulded onto the inner band.

16. A tyre according to any one of the preceding claims wherein the resiliently flexible covering is of non-pneumatic construction.

17. A tyre according to any one of the preceding claims wherein the resiliently flexible outer covering comprises a body of resilient material.

18. A tyre according to claim 17 wherein the body is substantially solid.

19. A tyre according to claim 17 wherein the body has at least one cavity formed therein.

20. A tyre according to claim 19 wherein the resiliently flexible outer covering comprises a moulded structure comprising a moulded body of resiliently deformable material and the or each cavity therein comprises a core hole extending into the moulded body from a face thereof.

21. A tyre according to claim 20 wherein the core hole is so shaped as to provide an outer dimensional characteristic at an outer zone at or near the face of the moulded body and an intermediate dimensional characteristic of the same character as the outer dimensional characteristic at an intermediate zone disposed inwardly of the outer zone, the intermediate dimensional characteristic being larger than the outer dimensional characteristic.

22. A tyre according to claim 21 wherein the intermediate and outer dimension characteristics comprise a dimension transverse to the inward extent of the core hole.

23. A tyre according to claim 21 wherein th intermediate and outer dimensional characteristics compris a cross-sectional area at a plane transverse to the inward extent of the core hole.

24. A tyre according to any one of claims 20 to 23 wherein the body has a second face and the core hole extends between the first and second faces, the core hole having a second outer zone at or near the second face of the body, the second outer zone having a second outer dimensional characteristic, at an outer zone at or near the second face and an intermediate dimensional characteristic of the same character as the outer dimensional characteristic at an intermediate zone disposed inwardly of the outer zone, the intermediate dimensional characteristic being larger than the second outer dimensional characteristic.

25. A tyre according to any one of claims 20 to 24 wherein the dimensional characteristics of the core hole change progressively between the or each outer zone and the intermediate zone.

26. A tyre according to any one of claims 20 to 25 wherein the intermediate zone is centrally located within the moulded body.

27. A tyre according to any one claims 20 to 26 wherein the or each core hole has a ceiling portion adjacent an outer portion of the body and a floor portion adjacent an inner portion of the body, the ceiling portion being shaped to provide the change in dimensional characteristics at the or each outer zone and the intermediate zone.

28. A tyre according to claim 27 wherein the ceiling portion is shaped so that it diverges from the floor portion in the inward direction of the core hole from the or each outer zone to the intermediate zone.

29. A tyre according to claim 28 wherein the outer covering has an outer face for engagement with the ground, the outer face having a profile with a central

region th reof raised with respect to side regions thereof, the ceiling portion of the or ach core hole being shaped to correspond generally to the profile of the outer face such that there is a generally uniform thickness between the ceiling portion of the core hole and the outer face of the tyre.

30. A central support having a circumferential support surface for supporting a tyre according to any one of the preceding claims.

31. A central support according to claim 30 wherein a guide means is provided for alignment of the tyre during fitting thereof on the central support.

32. A central support according to claim 31 wherein the guide means comprises a protrusion on the circumferential support surface for reception in a gap in the inner circumference of the tyre.

33. A central support according to claim 30, 31 or 32 comprising a wheel rim.

34. A wheel comprising a tyre according to any one of claims 1 to 29 fitted onto a central support according to any one of claims 30 to 33.

35. A moulded structure comprising a moulded body of resiliently deformable material and a core hole extending into the body from a face thereof, the core hole being so shaped as to provide an outer dimensional characteristic at an outer zone at or near the face of the body and an intermediate dimensional characteristic of the same character as the outer dimensional characteristic at an intermediate zone disposed inwardly of the outer zone, the intermediate dimensional characteristics being larger than the outer dimensional characteristic.

36. A moulded structure according to claim 35 wherein the core hole is so shaped as to provide an outer dimensional characteristic at an outer zone at or near the face of the moulded body and an intermediate dimensional characteristic of the same character as the outer dimensional characteristic

at an intermediate zone disposed inwardly of th outer zone, the interm diate dimensional characteristic being larger than the outer dimensional characteristic.

37. A moulded structure according to claim 36 wherein the intermediate and outer dimension characteristics comprise a dimension transverse to the inward extent of the core hole.

38. A moulded structure according to claim 36 wherein the intermediate and outer dimensional characteristics comprise a cross-sectional area at a plane transverse to the inward extent of the core hole.

39. A moulded structure according to any one of claims 35 to 38 wherein the body has a second face and the core hole extends between the first and second faces, the core hole having a second outer zone at or near the second face of the body, the second outer zone having a second outer dimensional characteristic, at an outer zone at or near the second face and an intermediate dimensional characteristic of the same character as the outer dimensional characteristic at an intermediate zone disposed inwardly of the outer zone, the intermediate dimensional characteristic being larger than the second outer dimensional characteristic.

40. A moulded structure according to any one of claims 35 to 39 wherein the dimensional characteristics of the core hole change progressively between the or each outer zone and the intermediate zone.

41. A moulded structure according to any one of claims 35 to 40 wherein the intermediate zone is centrally located within the moulded body.

42. A moulded structure according to any one claims 35 to 41 wherein the or each core hole has a ceiling portion adjacent an outer portion of the body and a floor portion adjacent an inner portion of the body, the ceiling portion

being shaped to provide the change in dim nsional characteristics at the or each outer zone and the intermediate zone.

43. A moulded structure according to claim 42 wherein the ceiling portion is shaped so that it diverges from the floor portion in the inward direction of the core hole from the or each outer zone to the intermediate zone.

44. A moulded structure according to any one of claims 35 to 43, wherein the moulded structure comprises a tyre or a tyre segment.

45. A moulded structure according to claim 44 wherein the tyre or tyre segment has an outer face for engagement with the ground, the outer face having a profile with a central region thereof raised with respect to side regions thereof, the ceiling portion of the or each core hole being shaped to correspond generally to the profile of the outer face such that there is a generally uniform thickness between the ceiling portion of the core hole and the outer face of the tyre.

46. A mould for producing a moulded structure according to any one of claims 35 to 45, the mould having a core for producing a respective core hole in the moulded structure, the core being configured to provide the variation in dimensional characteristics of the core hole described.

47. A tyre comprising a resiliently deformable annular body including an inner portion having an inner face for positioning on a support surface, an outer portion having an outer face disposed outwardly of the inner portion for engaging the ground, and opposed side faces extending between the inner and outer faces, and wherein a plurality of core holes are formed in the annular body to extend between the opposed side faces, the core holes each having a cross-sectional configuration which is not constant between the ends thereof and which provides a dimensional characteristic intermediate the ends thereof which is greater than a corresponding dimensional characteristic at or near the ends thereof.

48. A tyre segm nt comprising a resiliently deformable body including an inner portion having an inner face for positioning on a support surface, an outer portion having an outer face disposed outwardly of the inner portion for engaging the ground, and opposed side faces extending between the inner and outer faces, and wherein a core hole is formed in the annular body to extend between the opposed side faces, the core hole having a cross-sectional configuration which is not constant between the ends thereof and which provides a dimensional characteristic intermediate the ends thereof which is greater than a corresponding dimensional characteristic at or near the ends thereof.

49. A tyre substantially as herein described with reference to the accompanying drawings.

50. A tyre segment substantially as herein described with reference to the accompanying drawings.

51. A central support for a tyre substantially as herein described with reference to the accompanying drawings.

52. A wheel substantially as herein described with reference to the accompanying drawings.

53. A moulded structure substantially as herein described with reference to the accompanying drawings.

54. A mould substantially as herein described.

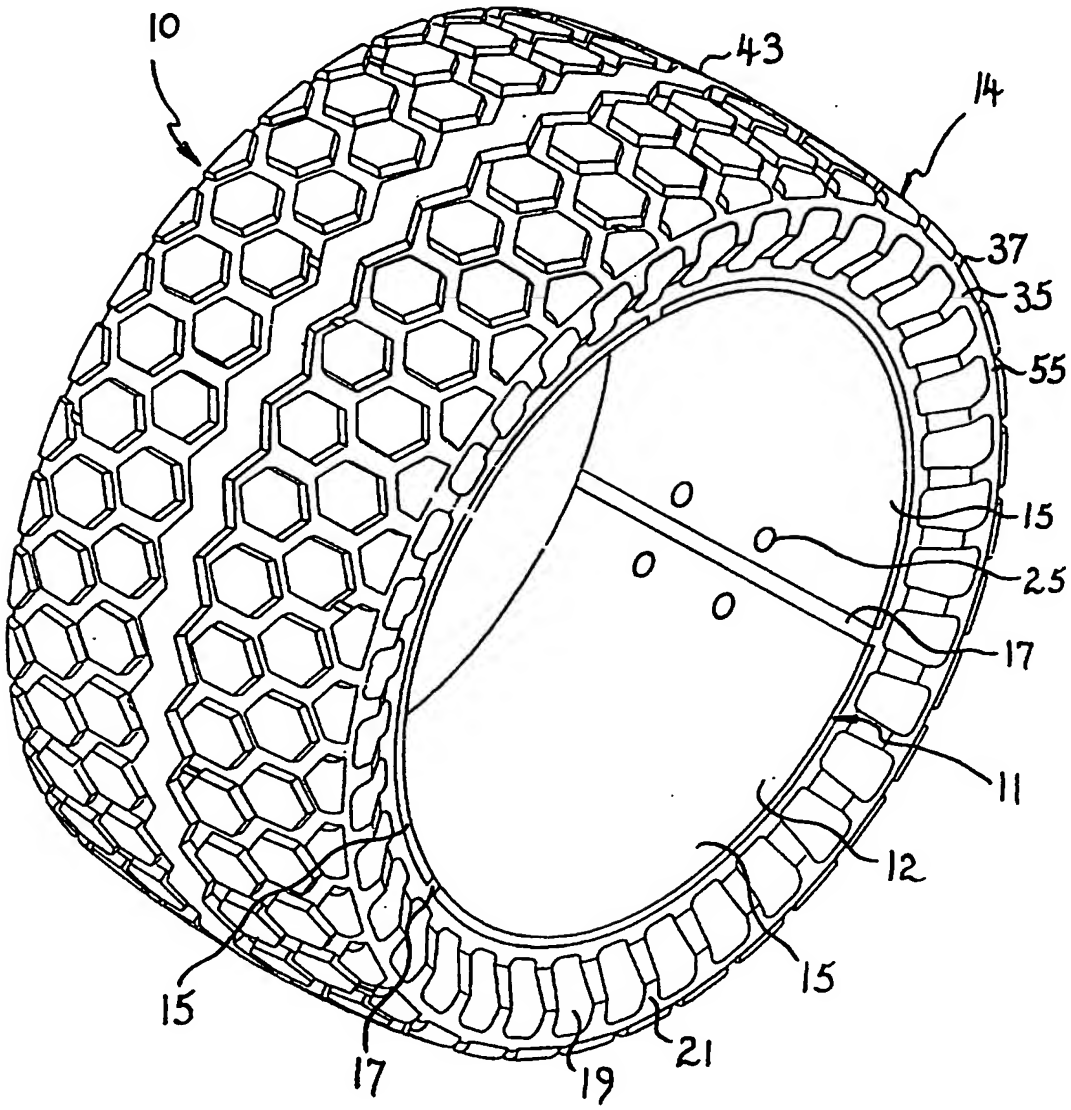

Fig. 1.

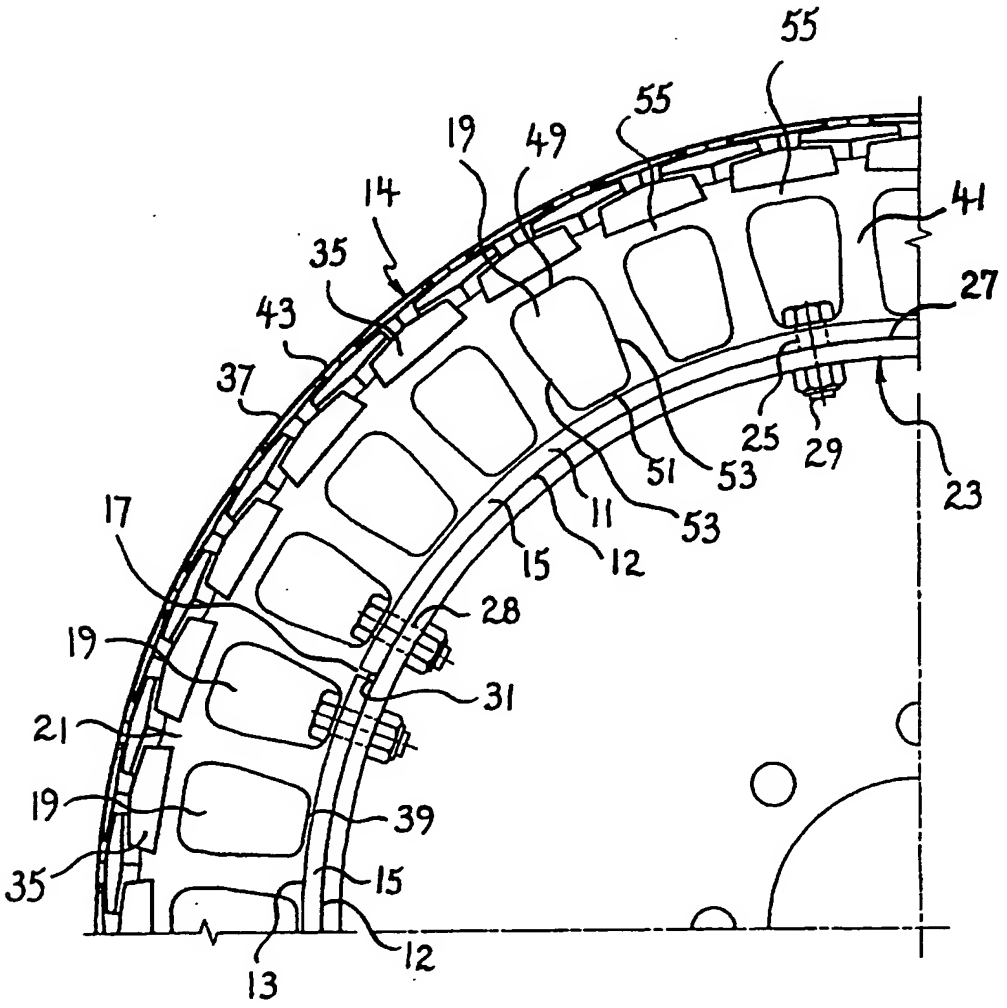
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Fig. 2.

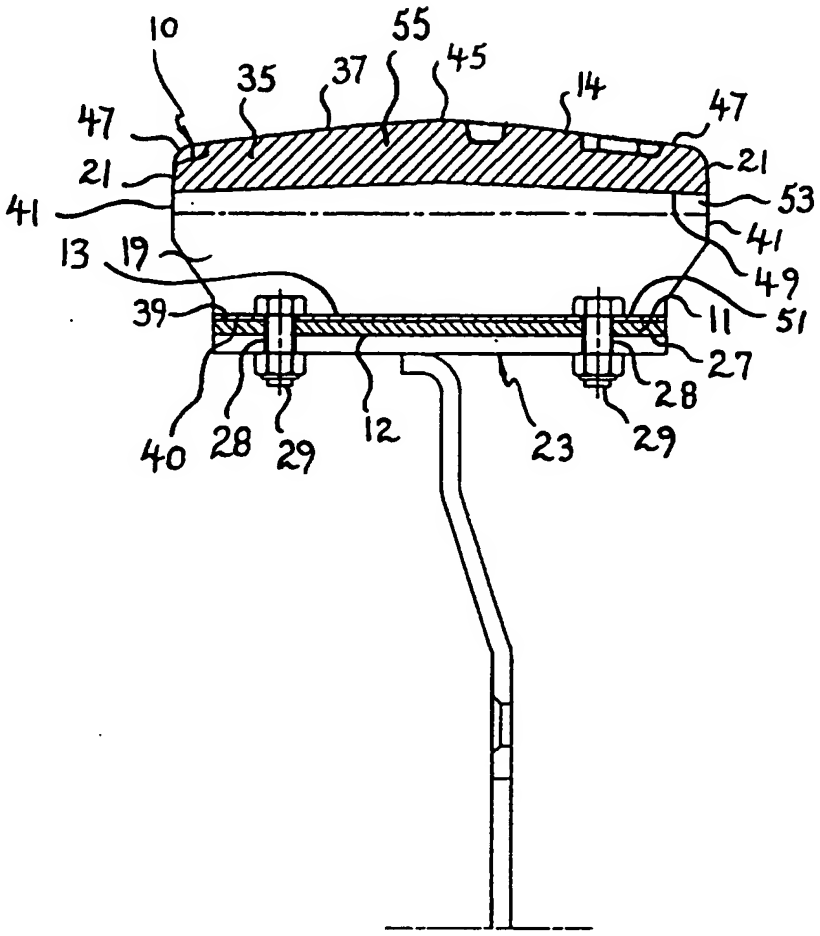
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Fig. 3

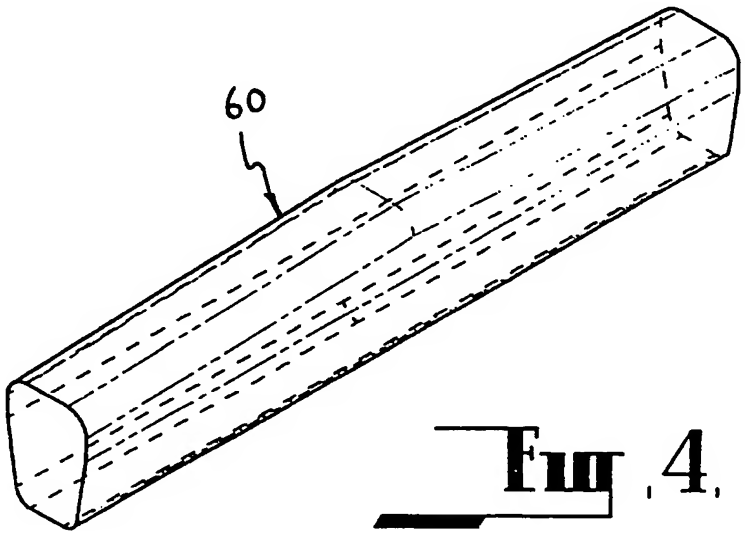

Fig. 4.

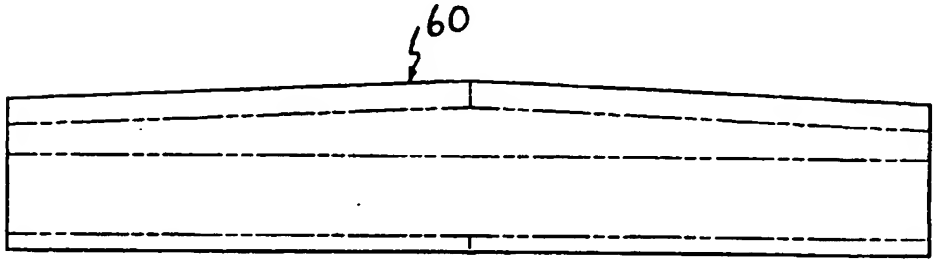

Fig. 5.

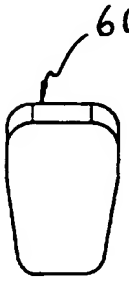

Fig. 6.

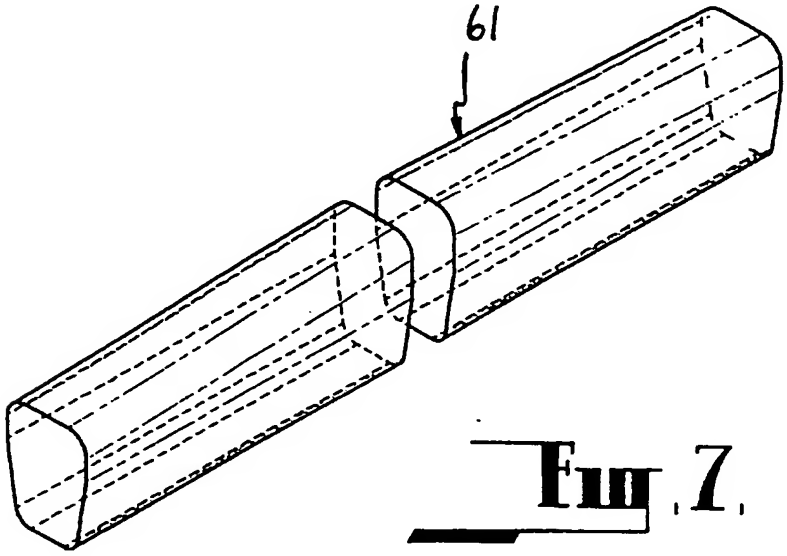

Fig. 7.

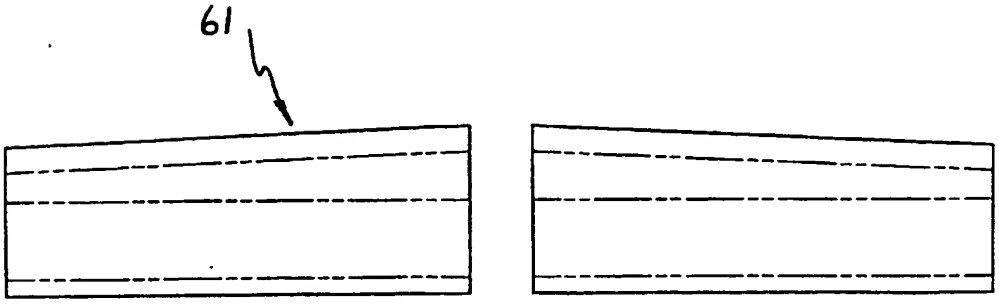

Fig. 8.

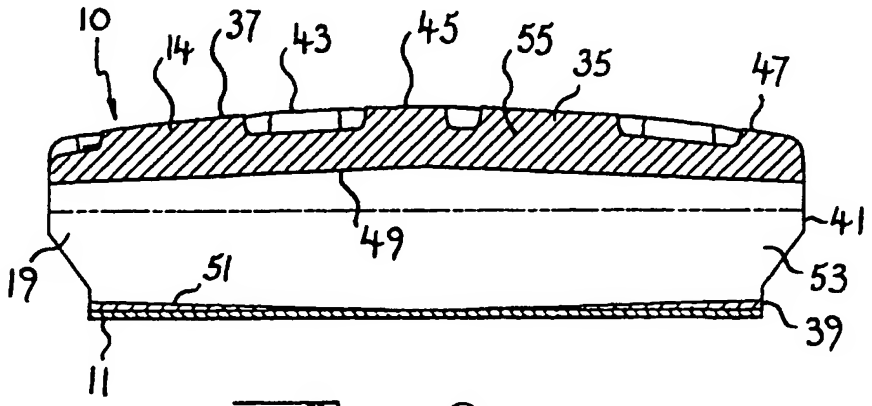

Fig. 9.

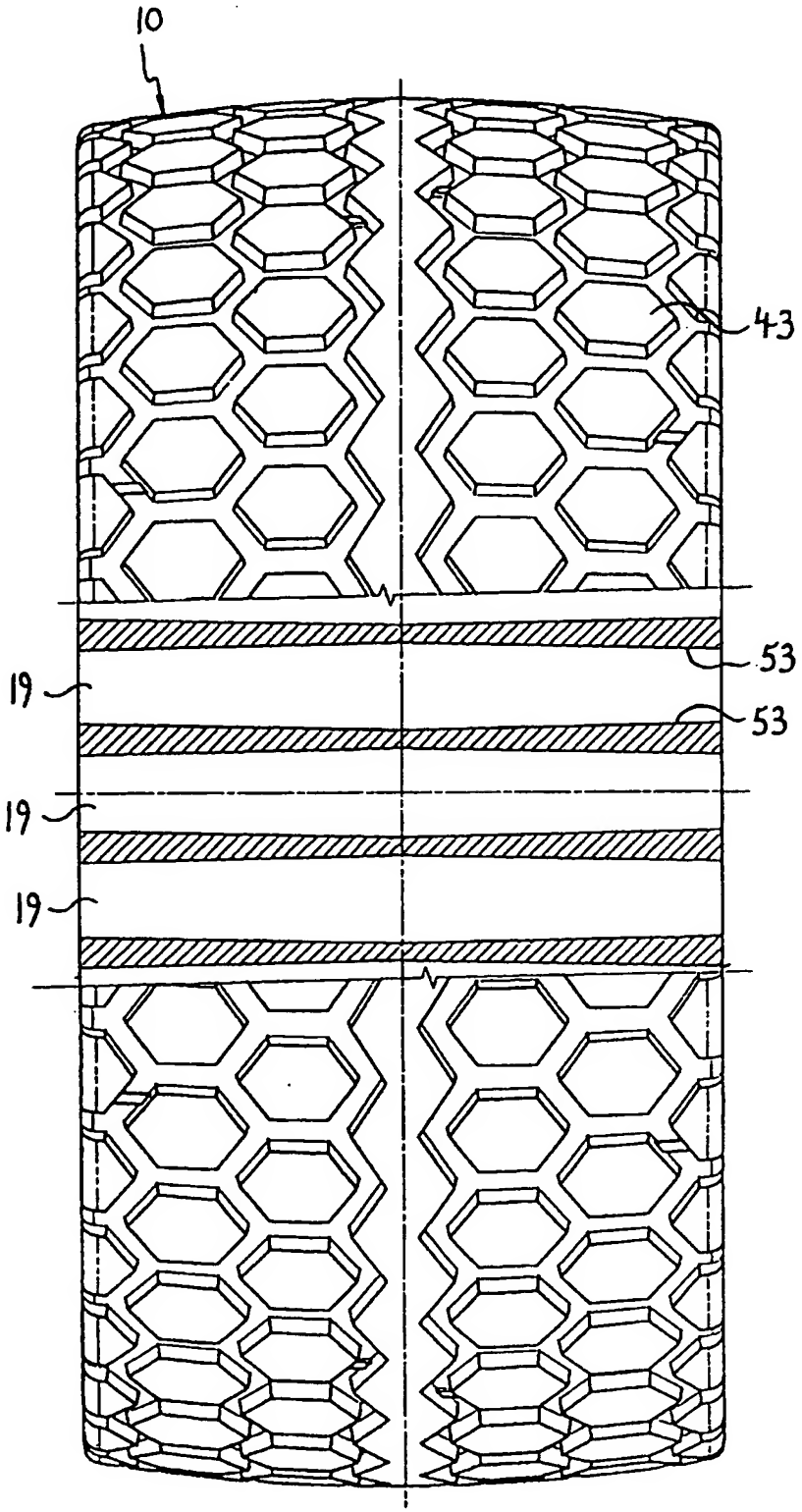

Fig 10

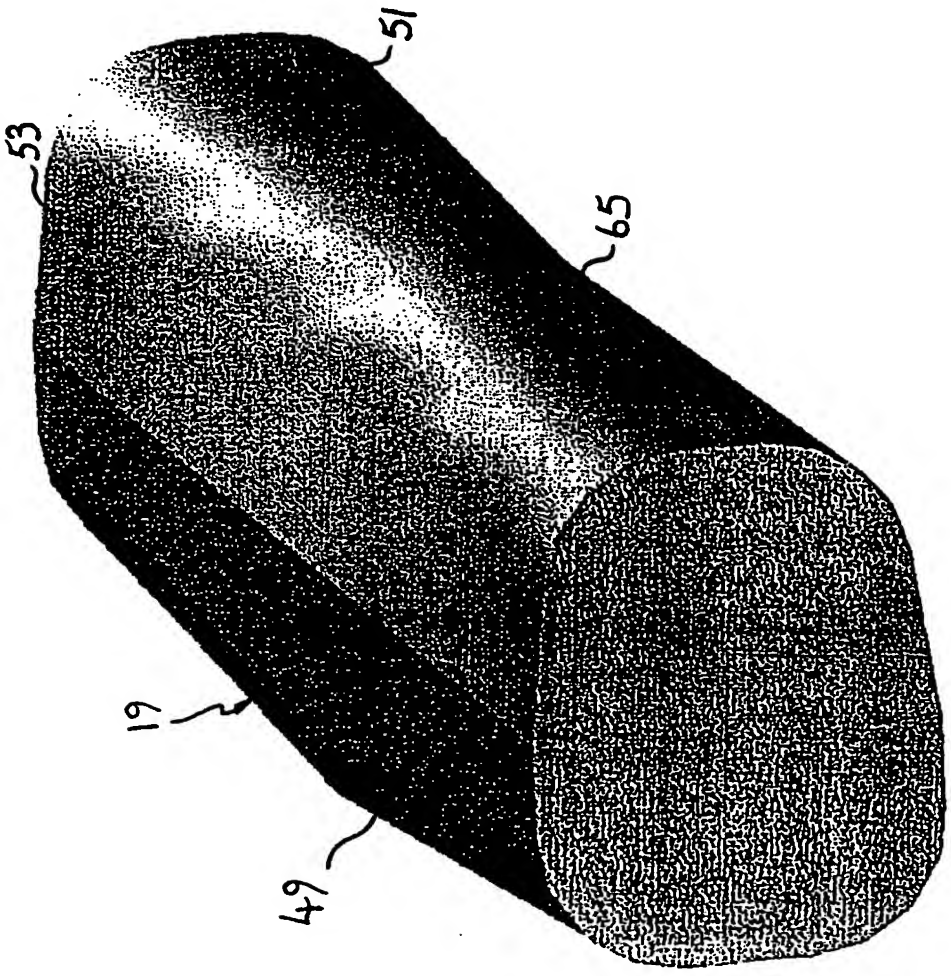

Fig. 11

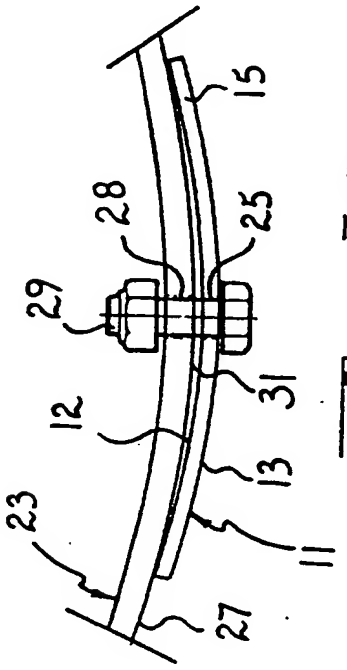

Fig 12

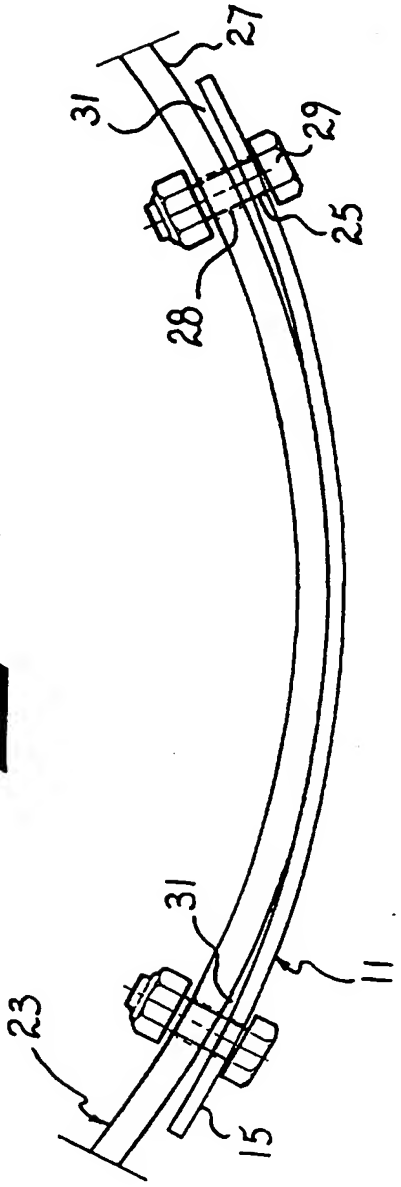

Fig 13

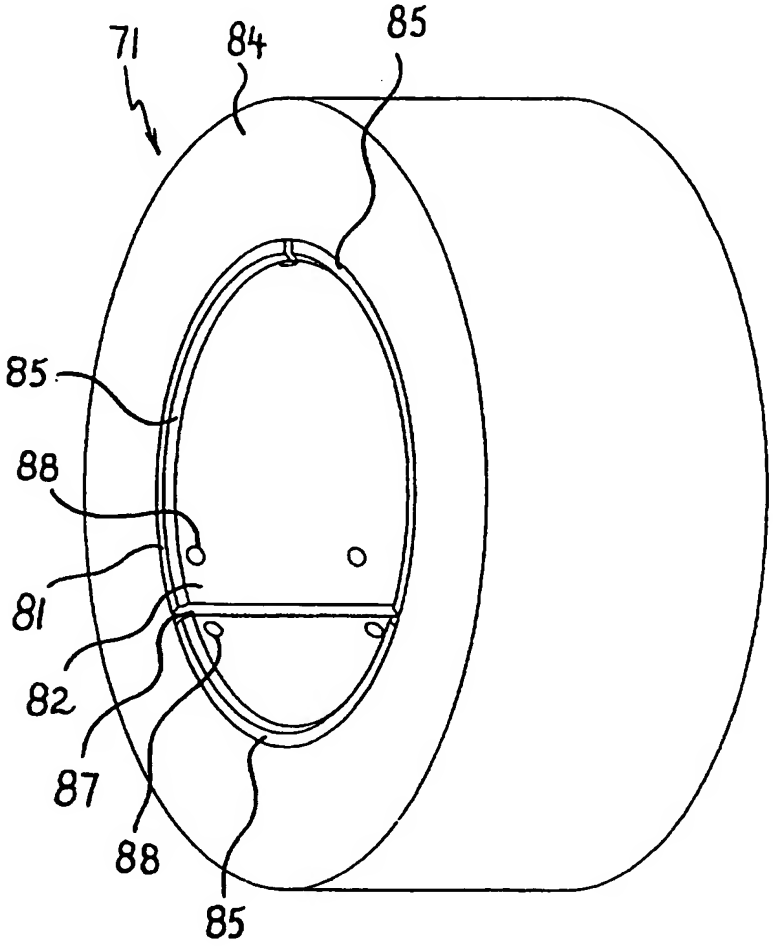

Fig 14

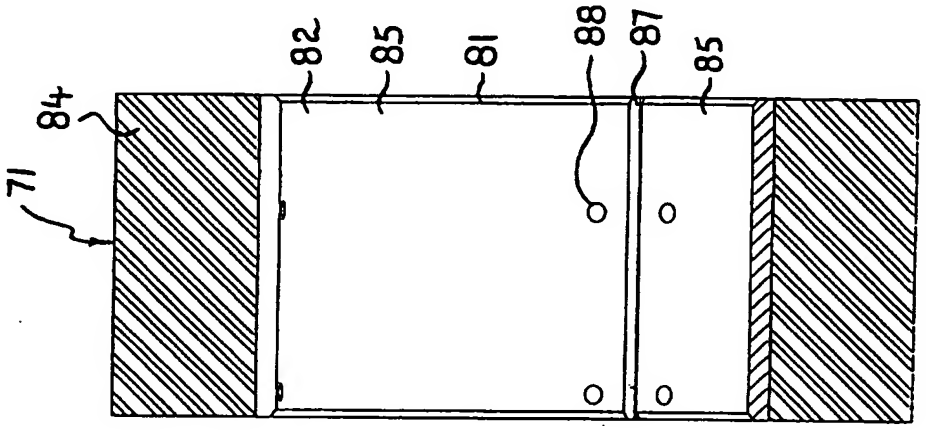

Fig 16

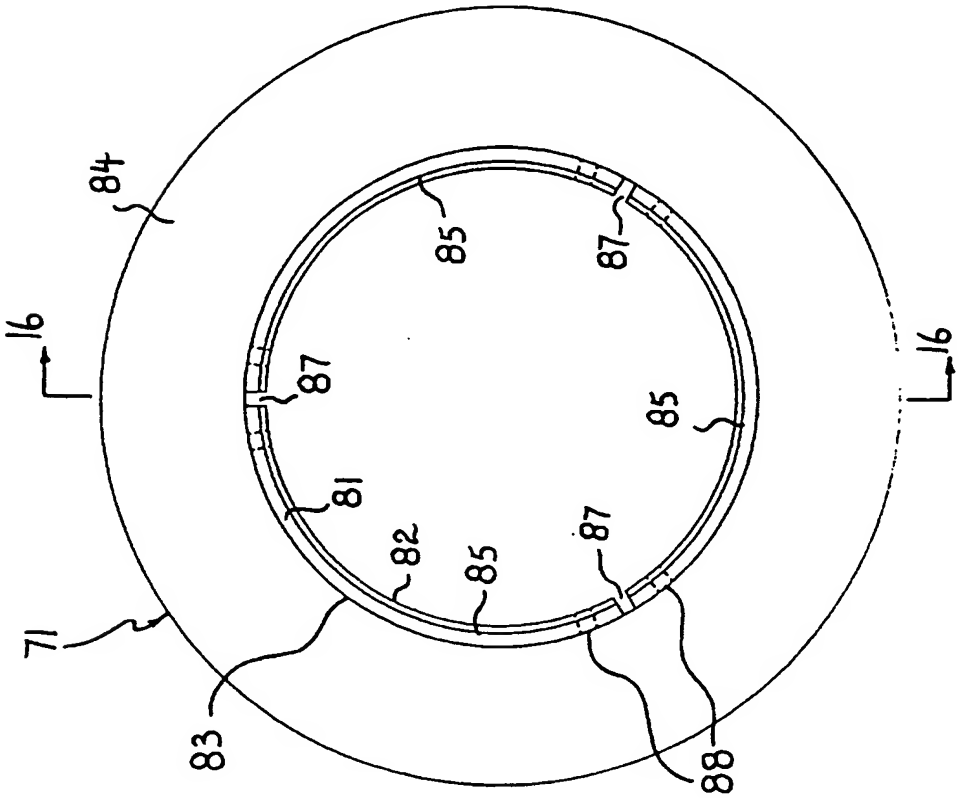

Fig 15

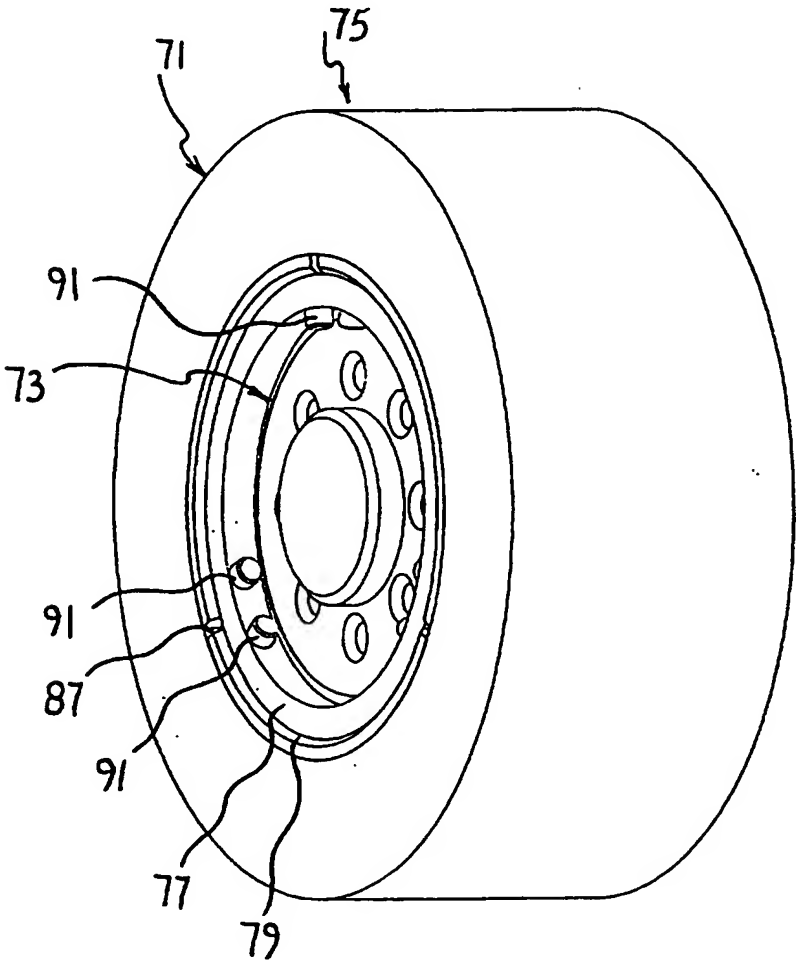

Fig. 17.

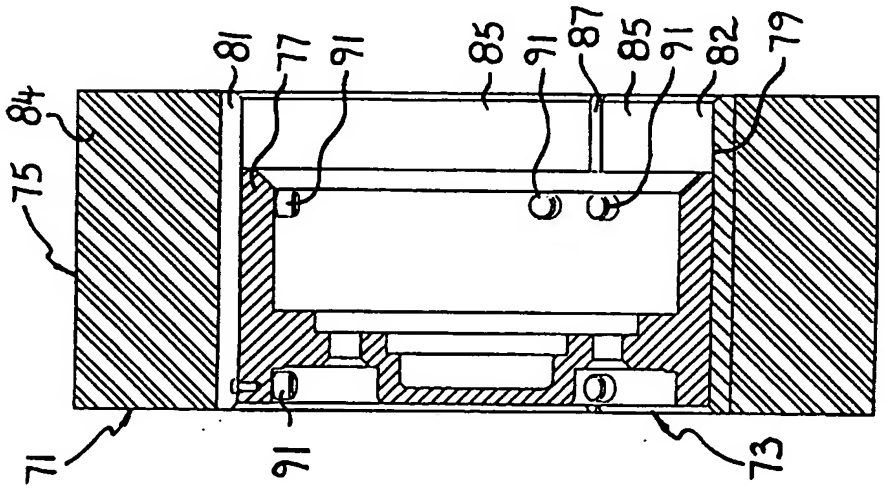
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Fig 19.

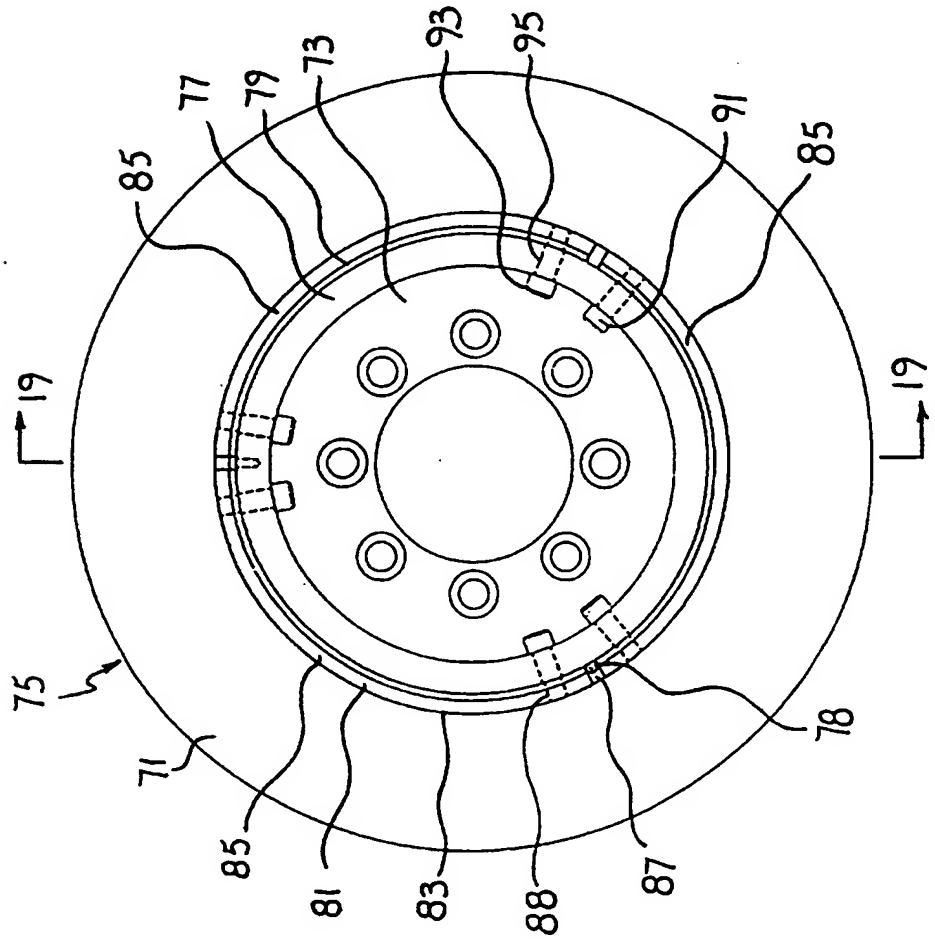
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Fig 18.

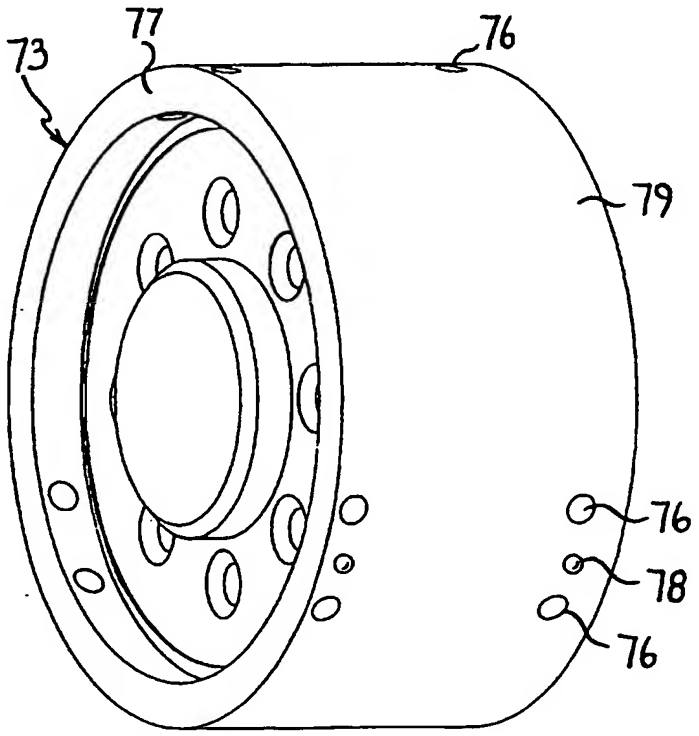

Fig 20

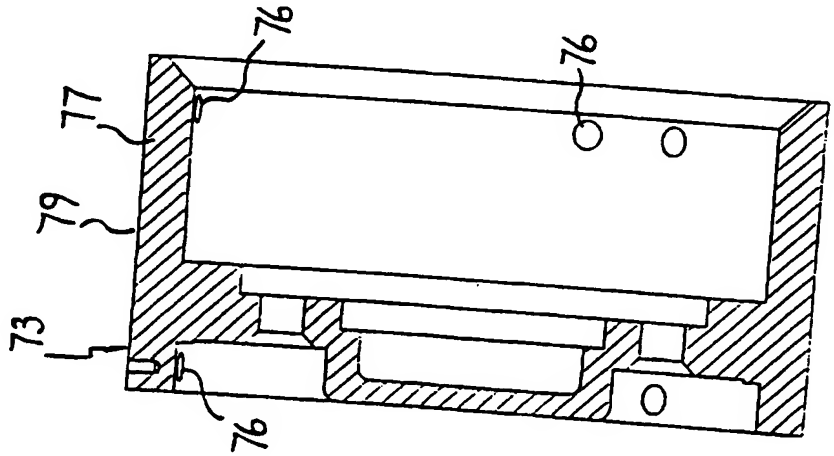

Fig. 22

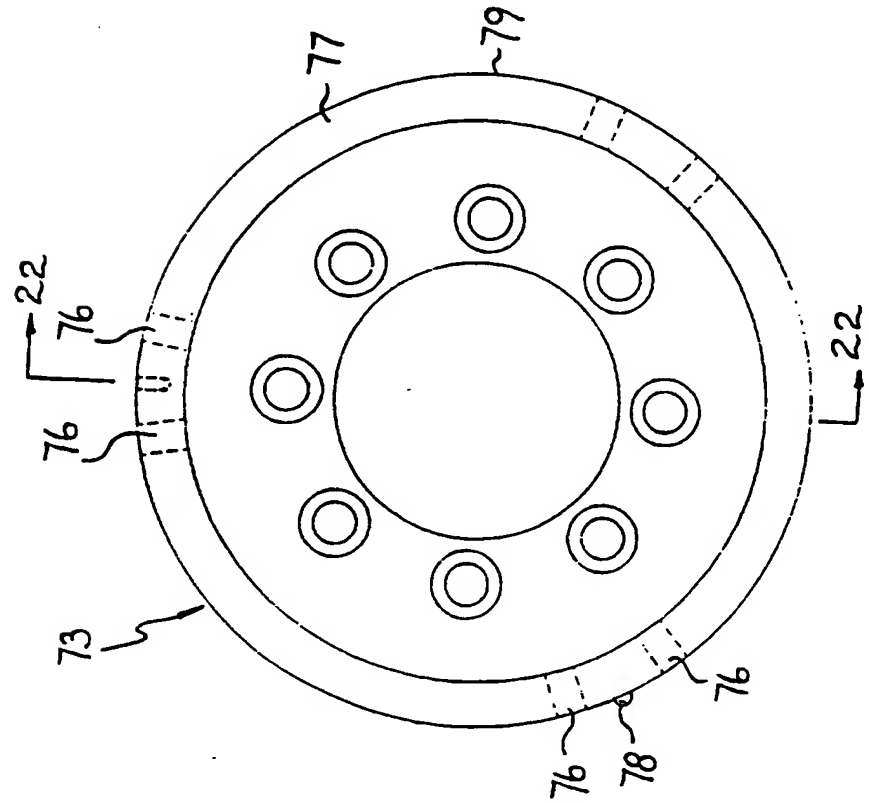

Fig. 21

INTERNATIONAL SEARCH REPORT

International Applicati n No.
PCT/AU 96/00032

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B60C 7/24, 7/26, 7/10, 7/08; B29C 33/42, 33/76, B29D 30/02

According to International Patent Classificati n (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: B60C 7/24, 7/26, 7/10, 7/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above, B29C 33/42, 33/76

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 1455844 A (LANG) 22 May 1923 Page 1 lines 24-31, claims and drawings	48, 50
A	US 1365539 A (PEPPLE) 11 January 1921 Page 1 lines 64-95 and drawings	47
X	FR 552323 A (BRUDENNE) 28 April 1923 Page 1 line 46 to page 3 line 65 and drawings	47

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
3 May 1996

Date of mailing of the international search report
13TH MAY 1996.

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INTERNATIONAL SEARCH REPORT

International Applicati n No.
PCT/AU 96/00032

C (Continuati n) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant t claim No.
X	US 2525196 A (BACON) 10 October 1950 Column 1 lines 28-32, claims and drawings	1, 2, 3, 7, 8, 12-18
A	US 1402947 A (MYERS) 10 January 1922 Page 1 lines 19-23 claims 1-4 and drawings	47
A	AU 64950/90 A (ALTRACK LIMITED) 2 May 1991 Page 4 lines 7-20, page 5 lines 19-28, page 6 lines 16-17 and drawings	48
X	US 3205929 A (KATZ) 14 September 1965 Column 1 lines 40-58 and drawings	1, 35-41
X	US 1725733 A (HARTER) 20 August 1929 Page 1 lines 49-79 and drawings	1, 2
X	AU 87334/75 B (507029) (BAYER AG) 16 June 1977 Page 4 lines 4-14, page 5 lines 3-17 and drawings figures 4, 5, 6 and 7	35-47
A	WO 91/17899 A1 (ALTRACK LIMITED) 28 November 1991 Abstract, page 5 lines 12-18 and drawings	48
X	AU 87419/75 B (502409) (BAYER AG) 16 June 1977 Page 2 line 24 to page 3 line 27 and drawings	35-41
X	AU 73153/87 A (FIRESTONE TIRE & RUBBER CO. THE) 26 November 1987 claim 1 and drawings	35-41, 44, 46
X	AU 58278/86 A (NRM CORPORATION) 18 December 1986 Page 12 line 20 to page 14 line 18 and drawings	35-41, 44, 46
X	AU 71944/87 A (MICHELIN AND CIE) 29 October 1987 Page 1 lines 1-2, claims 1 to 10 and drawings	35-41, 44, 46

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00032

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
AU	87419/75	AT	9583/75	BE	836795	BR	7508429
		CA	1031251	DE	2460050	ES	443607
		FR	2294865	GB	1522978	IL	48677
		IT	1052591	JP	51085104	LU	74038
		NL	7514663	SE	7514282	US	4037635
		ZA	7507919				
WO	9117899	AU	78693/91	BR	9106458	CN	1061187
		EP	530240	US	5390985	ZA	9103528
AU	87334/95	AT	9584/75	BE	836796	BR	7508405
		CA	1032454	DE	2460051	FR	2294866
		GB	1522323	IL	48676	IT	1052590
		JP	51085103	LU	74039	NL	7514662
		SE	7514281	US	4051883	ZA	7507920
AU	71944/87	BR	8701954	CA	1322265	CN	87103197
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INTERNATIONAL SEARCH REPORT

International Application No.
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This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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END OF ANNEX